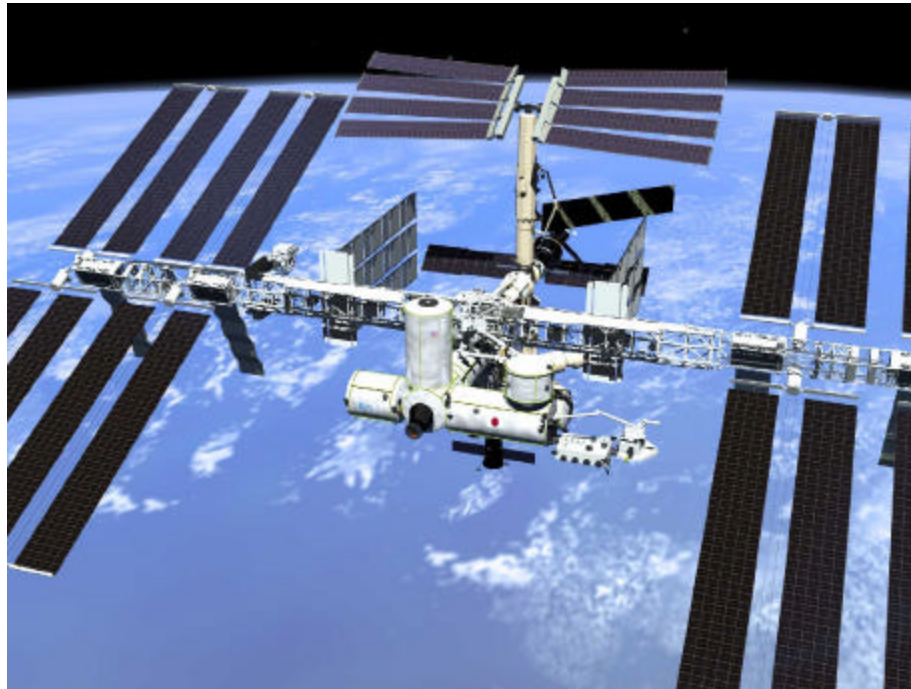# Model for Estimating Space Station Operations Costs (MESSOC)

What is MESSOC?

- A <u>M</u>odel for <u>E</u>stimating <u>S</u>pace <u>S</u>tation <u>O</u>perations <u>C</u>osts in the mature operations phase

- An operations cost and performance estimating tool using station and ground system characteristics

- A way of capturing the flow of operations activities and estimating the resultant cost through causal relationships

- A high-level model to compare alternative scenarios to inform program decisions

- Only one piece, but an important one, of the life-cycle cost estimate

How MESSOC Can Be Used

- **Long-term strategic-level resource envelope for users (e.g., crew time, upmass, power, robotic availability)**
- **Near-term tactical-level resource envelope for utilization planning**
- **International operations cost sharing analyses**
- **Operations costs/performance inputs to studies and plans (e.g., P3I and station growth studies)**
- **Comparison of budget submits against top-down estimates**
- **Tracking operations-related Technical Performance Measures (TPMs)**
- **Evaluation of change requests**

MESSOC Background

- **MESSOC has along history**
  - Initially supported by JSC (FY85-86), then by Level I and Level II (Reston, Code MSU, FY87-90)
  - Total funding approximately $0.75M
  - Extensive validation activities, both independent and within SSF

- **MESSOC has adapted to space station program changes**
  - Oct 1986 (Ver 1.2)   First demonstrated at JSC
  - Apr 1987 (Ver 1.3)   Incorporated CETF
  - Dec 1987 (Ver 1.4)   Incorporated SSOTF
  - Oct 1988 (Ver 2.0)   Validation version
  - Dec 1989 (Ver 2.1)   First controlled version
  - Dec 1990 (Ver 2.2)   Second controlled version

MESSOC 2.2 Validation Activities

- Centers were briefed on MESSOC (1989) and asked to provide comments on algorithms, documentation, and data. Centers were provided complete Version 2.0 documentation.

- RIDs were incorporated in Version 2.1 (first controlled version).

- Level II performed extensive beta testing of the software. Runs were tabulated and compared against hand calculation for accuracy.

- Level II let an independent contract with the Logistics Management Institute (LMI), an FFRDC with expertise in logistics models.

- Compared MESSOC results during POP "trueup" exercise (Dec 1990).

LMI Assessment of MESSOC

"Our general findings are that the algorithms define reasonable approaches, are mathematically correct, are comprehensive in their coverage, and are well integrated between logistics areas."

- LMI Briefing Book NS901TB1, October 1989, p.35

MESSOC Development Strategy

- **Recognize that operations involves many different functional areas**
- **Build on existing DoD/NASA models**
  - **Logistics**
  - **Training**
  - **Orbital mechanics**
  - **Launch vehicle performance**
- **Emphasize causal relationships in algorithms and equations**
- **Capture interactions among represented functional areas**
- **Recognize dynamic year-to-year relationships to accommodate changes in station configuration and operations activities**

MESSOC 3.0 Design Requirements

- **Functionality of MESSOC 2.2 with minor simplifications**

- **Programmed using Excel '97 and Excel '97 VBA**

- **Use a fully relational database structure in third normalized form; all datatables in Excel spreadsheets fully integrated with MESSOC**

- **Fully compatible with already-developed portions of SOCM**

- **Permit specific algorithms to be run separately**

- **Update all datatables and baseline scenario inputs for ISS**

- **Use "modern" GUIs for user inputs, options, and help files**

Note: Originally, MESSOC was developed under DOS 3.0, programmed in TurboPascal with databases separately maintained in dBase III+.
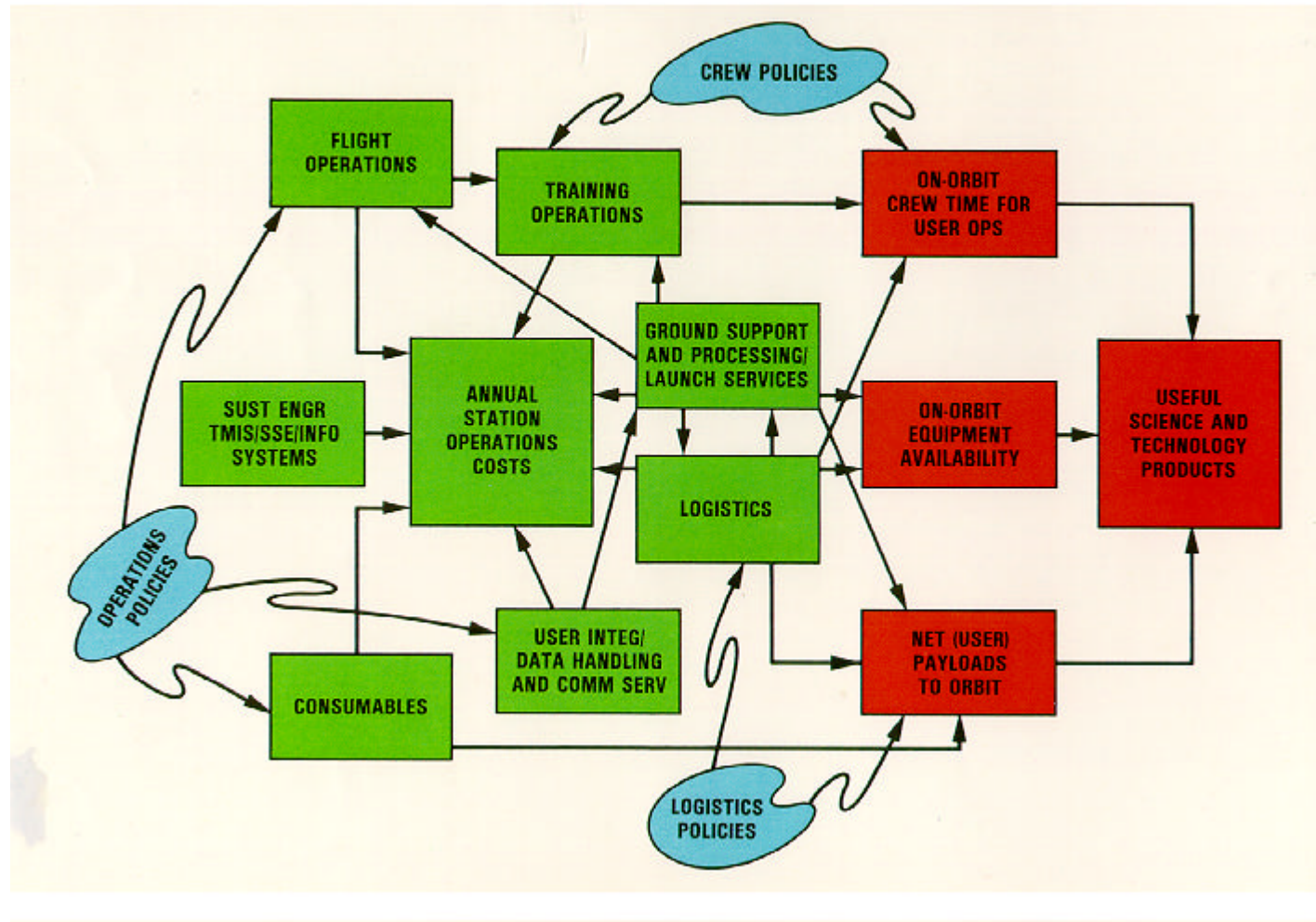
MESSOC 3.0 Architecture
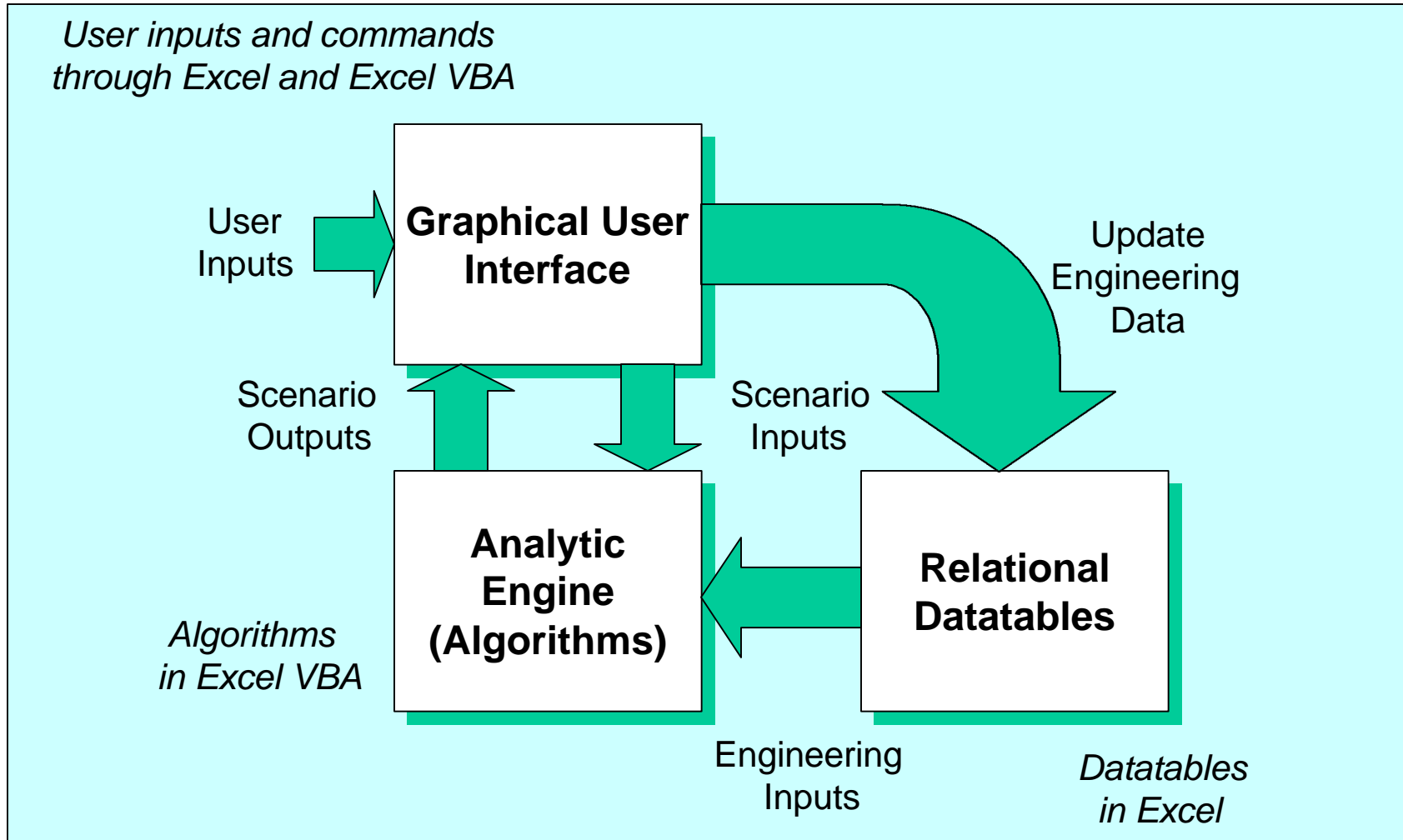
Conceptual View of MESSOC Algorithms

JPL

MESSOC Algorithms

- **Annual Cost By Function**
  - **SSCC/ESC maintenance and support**
  - **Training operations**
  - **Flight design**
  - **Flight planning**
  - **Flight implementation**
  - **Sustaining engineering**
  - **Information systems maintenance and support**
  - **Maintenance documentation, databases, procedures, and analysis**
  - **Inventory management**
  - **Ground transportation and handling**
  - **Intermediate/depot-level repairs**
  - **Flight equipment spares**

MESSOC Algorithms (Continued)

- **Annual Cost By Function**
  - **Element processing and reprocessing**
  - **Station consumables**
  - **GSE maintenance and support**
  - **User integration**
  - **Flight crew pay and allowances**
  - **Integration management and institutional support**
  - **Program taxes and reserves**
  - **NSTS/ELV launch services**
  - **Data handling operations**
  - **Communication (TDRSS/NASCOM) services**

MESSOC Algorithms (Continued)

- **Operations Performance**
  - Station mass
  - Station power
  - Pressurized volume
  - Growth mass
  - Max on-orbit availability
  - Probability of stockout
  - Upmass available
  - Downmass available
  - Recoverables mass
  - Recoverables volume
  - Recoverables mass sigma
  - Crewhours available
  - BMAC time
  - On-orbit CAP

  - Housekeeping time
  - On-the-job training time
  - Docking/prox ops time
  - EVA time
  - EVA preparation time
  - EVA observer time
  - EVA crewhours available
  - IVA time
  - Reboost altitude
  - Rendezvous altitude
  - Training loads
  - Required fuel deliveries
  - Consumables mass
  - Robotics utilization

Connections To Intelligent Synthesis Environment (ISE) ISS Application

- **Simulation results as MESSOC inputs**
  - **Assembly Database: Simulate the addition of a Station element to obtain IVA/EVA crewhours and robotic utilization**
  - **Logistics Database: Simulate on-orbit maintenance procedures to obtain IVA/EVA crewhours and robotic utilization for each ORU**
  - **Element Database:**
    - **Rapidly recompute Station frontal area for propellant requirements**
    - **Simulate Station element processing at KSC to obtain processing workyears by element and GSE requirements**
  - **Simulate rendezvous and docking to obtain IVA crewhours and robotic utilization by vehicle**

- **Advanced MESSOC results to guide payload designers and Station evolution decisions**
  - **Estimates of full utilization costs**
  - **Full marginal costs to compare to "market prices"**